Effect of Grazing Management on Diet Quality, Intake, and Digestion in Steers Grazing Native Rangeland in Western North Dakota

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Some production costs for the beef industry in western North Dakota are unnecessarily high because the industry relies on traditional pasture management practices that inefficiently capture the nutrients produced on a land base. These practices result in higher costs for the nutrients ingested by the animals and in increased annual production costs per animal. Development of efficient pasture management strategies requires an understanding of herbage nutritional quality curves, the seasonal quality of animal-selected diets, and the seasonal digestibility of and protein supply from forage managed with different grazing treatments.

A two-year collaborative graduate-student project evaluated the influence grazing management treatments applied during the growing season have on livestock forage intake, diet quality, digestion site, and protein flow for forage selected by grazing animals with ruminal and duodenal cannulas. Funding for portions of this project was provided from a Range Research Initiative.

Methods

Crossbred beef steers were fitted with indwelling ruminal and duodenal cannulas according to approved institutional animal care and use protocols. Steers were randomly assigned to the rotation grazing treatment and the seasonlong grazing treatment. Samples were taken from steer cannulas during collection periods in June, July, August, and September during the 2000 and 2001 grazing seasons.

Each collection period consisted of 11 days. On each collection day, steers were ruminally evacuated at dawn. The cannulated steers were staked by a 6-meter lead tied to a steel post in a designated site to reduce sampling time. The steers were allowed to graze for 30 to 60 minutes. The sampling procedures followed during this study were changed from the cited method of Hirschfeld, Kirby, Caton, Silcox, and Olson (1996), which allowed the cannulated steers to graze the entire treatment, and different from the published method of Johnson, Caton, Poland, Kirby, and Dhuyvetter (1998), which allowed the cannulated animals to graze freely. The length of grazing time used during this study was changed from that of the cited method of Hirschfeld et al. (1996), which had a grazing time of 60 to 90 minutes, and different from that of the method of Johnson et al. (1998), which had a grazing time of 60 minutes. After the allotted grazing time, steers were gathered, and diet masticate samples were removed from the rumen. Total evacuated ruminal contents were weighed and subsampled for determination of total, dry matter, and fluid fill. Samples were stored on ice until they were transported to freezer compartments for storage. On day 1, an additional sample from whole ruminal contents was collected and stored frozen. Later, bacterial cells were isolated from these samples and used to determine bacterial nitrogen-to-purine ratios. These ratios were evaluated to determine the levels of microbial protein synthesis. This information allowed distinction between microbial and dietary origins of the duodenal protein flow. The evacuated ruminal contents remaining after all samples were collected were returned to the rumens of the respective steers.

Masticate samples were transported frozen to the NDSU nutrition laboratory. All samples were lyophilized before being analyzed for nutrient composition (AOAC 1990). A subsample from each masticate sample was oven dried at 50°C and used for the estimation of in vitro digestibility (Tilley and Terry 1963).

Twice-daily ruminal dosing of chromic oxide began after evacuation procedures were completed on the morning of day 2 of each collection period and continued through day 11. Chromic oxide was used as an indigestible flow marker in the masticated ruminal contents. It was dosed via the rumen cannula at 0700 and 1900 hours daily for the duration of each collection period. Chromic oxide was preweighed into #8 gelatin capsules (8+/-0.005g) and stored in a cool, dry place until dosed. Fecal grab samples were taken at 0700, 1100, 1500, and 1900 hours on days 7 to 11. These daily samples were composited for the 5-day sampling period for each steer during each collection period.

Duodenal sampling began on day 7 and continued through day 11. Duodenal samples were collected at 0700, 1100, 1500, and 1900 hours daily. Approximately 250 ml of duodenal contents were collected from each steer at each sampling time.

Duodenal samples were composited for all sampling times for each steer and collection period. Duodenal samples were stored frozen until analyses were conducted.

On day 11, ruminal fluid was collected from each steer via suction strainer at 0700 hours. The ruminal fluid from each steer was placed in 12 in vitro tubes and used as inoculum for in vitro digestibility estimates. In vitro digestibility estimates were conducted for 3 dried and ground masticate samples, 3 blank samples, and 3 standard samples. After 48 hours of incubation, the contents of the in vitro tubes were frozen to stop microbial fermentation and transported to the NDSU nutrition laboratory for the second stage of the in vitro digestion procedure. In vitro indigestibility and fecal output estimates were used to estimate forage intake. Chromium was used as the flow marker and was used to estimate duodenal organic matter flow. Summarized data provided intake, chemical composition, site of digestion, degraded and undegraded intake protein supply, and microbial efficiency of grazed forage diets as influenced by season and grazing treatment.

Results

Data collected were reported in a graduate student thesis. With the procedures used during this study, the student found few differences between the seasonlong and rotation treatments.

Discussion

The landscape of the study area consists of variable topographic relief, range sites, and soil types. The vegetation characteristics along a landscape transect for each treatment vary on a gradient from high to low. The quantitative values for samples along the vegetation gradient on different treatments are not necessarily mutually exclusive because a portion of the gradient on one treatment can have the same numerical values as a different portion of the gradient on the other treatment.

The concept of landscape sampling to compare values across the vegetation gradient of the range sites for treatment A with values across the vegetation gradient of the range sites for treatment B is followed when cannulated steers are allowed to freely graze an entire treatment, as with the methods reported in Hirschfeld et al. (1996) and Johnson et al. (1998). Animals given adequate time to cover the entire treatment have the opportunity to graze each of the various vegetation sites in proportion to the site's presence on that treatment.

The concept of landscape sampling does not apply when the cannulated steers are restricted by staking to one location and are not permitted access to all of the vegetation sites, as was done in this study. The concept of range site sampling should have been followed. Treatment comparisons following the concept of range site sampling require selection of identical range sites in each treatment.

The sample sites in this study were not verified as being identical range sites across all treatments. Grazing site selection was based on similar appearance of soil and vegetation type. Data collected on these arbitrary points along the gradient of vegetation values on each treatment compare only the numerical relationship of the selected sites and the degree of differences. Data collected from unverified sample sites can produce results indicating that grazing site A has values greater than, equal to, or less than values of grazing site B, but such results do not evaluate treatment effect.

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